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Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



77B/882/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER: IEC 61000-4-4 ED4	
DATE OF CIRCULATION: 2023-12-01	CLOSING DATE FOR COMMENTS: 2024-01-26
SUPERSEDES DOCUMENTS: 77B/880/RR	

IEC SC 77B : HIGH FREQUENCY PHENOMENA	
SECRETARIAT: France	SECRETARY: Mr Franck GRUFFAZ
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 61	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☒ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

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Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 4-4: Testing and measurement techniques –
Electrical fast transient/burst immunity test****FOREWORD**

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International Standard IEC 61000-4-4 has been prepared by subcommittee 77B: High frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms Part 4-4 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*.

This forth edition cancels and replaces the third edition published in 2012 and constitutes a technical revision.

This forth edition improves and clarifies the following:

- testing for both repetition frequencies to avoid different testing at different laboratories;
- Because in situ tests cannot be performed in a controlled environment, this test method has been moved into a new Annex E.

107 The text of this standard is based on the following documents:

FDIS	Report on voting
77B/670/FDIS	77B/673/RVD

108
109 Full information on the voting for the approval of this standard can be found in the report on
110 voting indicated in the above table.

111 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

112 The list of all currently available parts of the IEC 61000 series, under the general title
113 *Electromagnetic compatibility (EMC)*, can be found on the IEC web site.

114 The committee has decided that the contents of this publication will remain unchanged until
115 the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data
116 related to the specific publication. At this date, the publication will be

- 117 • reconfirmed,
118 • withdrawn,
119 • replaced by a revised edition, or
120 • amended.

121

122

INFORMATION TO NATIONAL COMMITTEES

This section is provided to National Committees for information and will be removed from the standard at next stage.

For clarification of misunderstandings or misinterpretation arising due to comparison between IEC 61000-4-4 Edition 3 and future Edition 4, the following issue is addressed:

1. Adding a CDN to the test equipment to be used for coupling to signal lines

MT12 is currently working to add available CDNs for coupling into signal lines. This includes a test setup and calibration procedures. MT12 try to complete this work when all relevant data has been collected and comparison of the results between the use of the “new” CDN vs. the currently used capacitive coupling clamp have been verified.

2. Evaluation of test results

Clause 9 of this standard basically describes the performance criterion in general terms. Actually the performance criterion can be different depending on the EUT and therefore are product dependent. Product related issues are addressed in product standards specified by product committees and are not subject of this basic standard as outlined in 77/603/INF. This lead to a discussion at the last TC77 plenary meeting including a proposal to address this issue in form of a guideline or information to product committees including to address a more specific impact of the covered phenomena (i.e. ESD within 61000-4-4) when evaluating test results.

Considering this proposal, Clause 9 has been moved into a “new” informative annex emphasizing the impact of EFT/B testing on the EUT when evaluating the test results including guidance and information when specifying the applicable performance criterion.

TC77 has expressed their intention to address this issue in a DC document. Future modification to this annex F can be necessary depending on the outcome decided by TC77.

123

124 INTRODUCTION

125 IEC 61000 is published in separate parts, according to the following structure:

126 **Part 1: General**

127 General considerations (introduction, fundamental principles)

128 Definitions, terminology

129 **Part 2: Environment**

130 Description of the environment

131 Classification of the environment

132 Compatibility levels

133 **Part 3: Limits**

134 Emission limits

135 Immunity limits (in so far as they do not fall under the responsibility of the product
136 committees)

137 **Part 4: Testing and measurement techniques**

138 Measurement techniques

139 Testing techniques

140 **Part 5: Installation and mitigation guidelines**

141 Installation guidelines

142 Mitigation methods and devices

143 **Part 6: Generic standards**

144 **Part 9: Miscellaneous**

145 Each part is further subdivided into several parts, published either as international standards
146 or as technical specifications or technical reports, some of which have already been published
147 as sections. Others are published with the part number followed by a dash and a second
148 number identifying the subdivision (example: IEC 61000-6-1).

149 This part is an international standard which gives immunity requirements and test procedures
150 related to electrical fast transients/bursts.

151

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test

1 Scope

This part of IEC 61000 relates to the immunity of electrical and electronic equipment to repetitive electrical fast transients/bursts. It gives immunity requirements, test and calibration methods related to electrical fast transients/bursts. It additionally defines test levels and establishes test and calibration procedures.

The object of this standard is to establish a common and reproducible reference in order to evaluate the immunity of electrical and electronic equipment when subjected to electrical fast transient/bursts on supply, signal, control and earth ports. This part of IEC 61000 specifies how to test the immunity of an equipment or system against fast transients/bursts.

NOTE As described in IEC Guide 107, this is a basic EMC publication for use by product committees of the IEC. As also stated in Guide 107, the IEC product committees are responsible for determining whether this immunity test standard is applied or not, and if applied, they are responsible for determining the appropriate test levels and performance criteria.¹

The standard specifies:

- test voltage waveform;
- test levels;
- equipment used for test and calibration;
- calibration and verification procedures of test equipment;
- test setup;
- test procedure.

The standard gives specifications for tests in laboratories. Measurement uncertainty and in-situ testing considerations are also provided.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050-161, as well as the following apply.

¹ TC 77 and its subcommittees are prepared to co-operate with product committees in the evaluation of the value of particular immunity tests for their products.

192 NOTE Several of the most relevant terms and definitions from IEC 60050-161 are presented among the
193 definitions below.

194 **3.1.1**
195 **auxiliary equipment**
196 **AE**

197 equipment necessary to provide the equipment under test (EUT) with the signals and/or power
198 required for normal operation and equipment to verify the performance of the EUT

199 **3.1.2**
200 **burst**
201 sequence of a limited number of distinct pulses or an oscillation of limited duration

202 [SOURCE: IEC 60050-161:1990, 161-02-07]

203 **3.1.3**
204 **calibration**
205 set of operations which establishes, by reference to standards, the relationship which exists,
206 under specified conditions, between an indication and a result of a measurement

207 Note 1 to entry: This term is based on the "uncertainty" approach.

208 Note 2 to entry: The relationship between the indications and the results of measurement can be expressed, in
209 principle, by a calibration diagram.

210 [SOURCE: IEC 60050-311:2001, 311-01-09]

211 **3.1.4**
212 **coupling**
213 interaction between circuits, transferring energy from one circuit to another

214 **3.1.5**
215 **common mode (coupling)**
216 simultaneous coupling to all lines versus the RGP

217 **3.1.6**
218 **coupling clamp**
219 device of defined dimensions and characteristics for common mode coupling of the
220 disturbance signal to cables attached to the EUT without any galvanic connection

221 **3.1.7**
222 **coupling network**
223 electrical circuit for the purpose of transferring energy from one circuit to another

224 **3.1.8**
225 **decoupling network**
226 electrical circuit for the purpose of preventing EFT/B voltage applied to the EUT from affecting
227 other devices, equipment or systems which are not under test

228 **3.1.9**
229 **degradation** (in performance)
230 undesired departure in the operational performance of any device, equipment or system from
231 its intended performance

232 Note 1 to entry: The term "degradation" can apply to temporary or permanent failure.

233 [SOURCE: IEC 60050-161:1990, 161-01-19]

234 **3.1.10**
235 **electromagnetic compatibility (EMC)**
236 ability of an equipment or system to function satisfactorily in its electromagnetic environment
237 without introducing intolerable electromagnetic disturbances to anything in that environment

238 [SOURCE: IEC 60050-161:2018, 161-01-07]

239 **3.1.11**
240 **EUT**
241 equipment under test

242 **3.1.12**
243 **immunity** (to a disturbance)
244 ability of a device, equipment or system to perform without degradation in the presence of an
245 electromagnetic disturbance

246 [SOURCE: IEC 60050-161:1990, 161-01-20]

247 **3.1.13**
248 **port**
249 particular interface of the EUT with the external electromagnetic environment

250 **3.1.14**
251 **pulse width**
252 interval of time between the first and last instants at which the instantaneous value reaches
253 50 % value of the rising and falling edge of the pulse

254 [SOURCE: IEC 60050-702:1992, 702-03-04, modified]

255 **3.1.15**
256 **reference ground plane (RGP)**
257 flat conductive surface that is at the same electric potential as reference ground, which is
258 used as a common reference, and which contributes to a reproducible parasitic capacitance
259 with the surroundings of the equipment under test (EUT)

260 NOTE to entry In some regions, the term 'earth' is used in place of 'ground'.

261 [SOURCE: IEC 60050-161:2014, 161-04-36]

262 **3.1.16**
263 **rise time**
264 interval of time between the instants at which the instantaneous value of a pulse first reaches
265 10 % value and then the 90 % value

266 [SOURCE: IEC 60050-161:1990, 161-02-05, modified]

267 **3.1.17**
268 **transient**
269 pertaining to or designating a phenomenon or a quantity which varies between two
270 consecutive steady states during a time interval which is short compared with the time-scale
271 of interest

272 [IEC 60050-161:1990, 161-02-01]

273 **3.1.18**

274 **unsymmetric mode (coupling)**

275 single line coupling versus the RGP

276 **3.1.19**

277 **verification**

278 set of operations which is used to check the test equipment system (e.g. the test generator
279 and the interconnecting cables) and to gain confidence that the test system is functioning
280 within the specifications given in Clause 6

281 Note 1 to entry: The methods used for verification may be different from those used for calibration.

282 Note 2 to entry: For the purposes of this basic EMC standard this definition is different from the definition given in
283 IEC 60050-311:2001, 311-01-13.

284 **3.2 Abbreviations**

285	AE	Auxiliary Equipment
286	CDN	Coupling/Decoupling Network
287	EFT/B	Electrical Fast Transient/Burst
288	EMC	ElectroMagnetic Compatibility
289	ESD	ElectroStatic Discharge
290	EUT	Equipment Under Test
291	MU	Measurement Uncertainty
292	PE	Protective Earth
293	RGP	Reference Ground Plane

294 **4 General**

295 The repetitive fast transient test is a test with bursts consisting of a number of fast transients,
296 coupled into power, control, signal and earth ports of electrical and electronic equipment.
297 Significant for the test are the high amplitude, the short rise time, the high repetition
298 frequency and the low energy of the transients.

299 The test is intended to demonstrate the immunity of electrical and electronic equipment when
300 subjected to types of transient disturbances such as those originating from switching
301 operations (interruption of inductive loads, relay contact bounce, etc.).

302 **5 Test levels**

303 The preferred test levels for the electrical fast transient test, applicable to power, control,
304 signal and earth ports of the equipment are given in Table 1.

305

Table 1 – Test levels

Open circuit output test voltage and repetition frequency of the impulses				
Level	Power ports ^a , earth port (PE)		Signal and control ports	
	Voltage peak kV	Repetition frequencies kHz	Voltage peak kV	Repetition frequencies kHz
1	0,5	5, 100	0,25	5, 100
2	1	5, 100	0,5	5, 100
3	2	5, 100	1	5, 100
4	4	5, 100	2	5, 100

^a Power ports consist of either AC mains or DC mains.

306 Guidance to select test levels is given in Annex B.

307 6 Test equipment

308 6.1 Overview

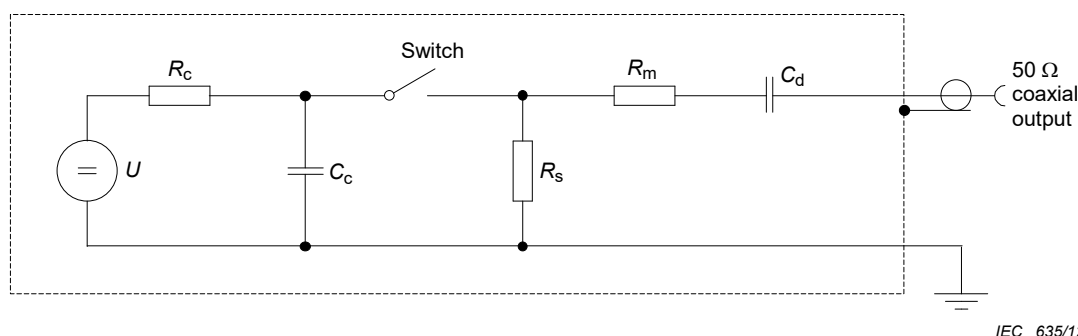
309 The calibration procedures of 6.2.3, 6.3.2 and 6.4.2 ensure the correct operation of the test
 310 generator and coupling/decoupling networks making up the test setup so that the intended
 311 waveform is delivered to the EUT.

312 6.2 Burst generator

313 6.2.1 General

314 The simplified circuit diagram of the generator is given in Figure 1. The circuit elements C_c ,
 315 R_s , R_m , and C_d are selected so that the generator delivers a fast transient under open circuit
 316 conditions and with a $50\ \Omega$ resistive load. The effective output impedance of the generator
 317 shall be $50\ \Omega$.

318



IEC 635/12

Components

U	high-voltage source
R_c	charging resistor
C_c	energy storage capacitor
R_s	impulse duration shaping resistor
R_m	impedance matching resistor
C_d	d.c. blocking capacitor
Switch	high-voltage switch

NOTE The characteristics of the switch together with stray elements (inductance and capacitance) of the layout shape the required rise time.

Figure 1 – Simplified circuit diagram showing major elements of a EFT/B generator

6.2.2 Characteristics of the EFT/B generator

The characteristics of the fast transient/burst generator are the following.

- Output voltage range with 1 000 Ω load shall be at least 0,24 kV to 3,8 kV.
- Output voltage range with 50 Ω load shall be at least 0,125 kV to 2 kV.

The generator shall be capable of operating under short-circuit conditions without being damaged.

Characteristics:

- polarity: positive/negative
- output type: coaxial, 50 Ω
- repetition frequency: (see Table 2) ± 20 %
- relation to a.c. mains: asynchronous
- burst duration: (15 $\pm$ 3) ms at 5 kHz
- (see Figure 2) (0,75 $\pm$ 0,15) ms at 100 kHz
- burst period: (300 $\pm$ 60) ms
- (see Figure 2)
- wave shape of the pulse
 - into 50 Ω load
 - rise time $t_r = (5 \pm 1,5)$ ns
 - pulse width $t_w = (50 \pm 15)$ ns
 - peak voltage = according to Table 2, ± 10 %
 - (see Figure 3 for the 50 Ω wave shape)